Comment on Mu2e Document 1517: “TS Magnetic Field Measurement”

Jim Miller, BU

Discussions have been held, and it is accepted by the Solenoid Group, that specifications of the field line alignment will need to be established for the three solenoids. A requirement on measurement of the position of the central field line is already in the Magnetic Field Measurements documents. Several means to measure alignment of the field lines have been proposed for Mu2e, including a full map of the three field components throughout the solenoid volumes, using a modified current-carrying wire, and using a beta source to map the field lines.

The Solenoid Magnet team has previously recognized the need for specifications on the alignment of the field lines from the Production Target to the Stopping Target. Discussion has begun on this subject, but because of the time required to get ready for the reviews, and because many of the studies required to understand the requirements on coil positioning have not yet been completed, it was decided to delay establishing specifications until more careful studies could be done after the review.

The need for alignment of the field lines was especially apparent when it was discovered that it is possible to transport >100 MeV/c particles down the beam line, if the target is placed a few centimeters too low below the solenoid central axis, or if the field lines are misaligned so that they carry high momentum particles from a centered production target to the high momentum “window” at the entrance of the TS (see Mu2e docDB # 923). For example this could happen if the field lines from the Production Target to the entrance of the Transport Solenoid droop by a couple centimeters over a couple of meters; since particles spiral along the magnetic field lines, this would carry electrons into the high momentum acceptance window of the TS. Good field line alignment, along with good symmetry of the other field lines about the central field line, is also needed to assure proper operation of the collimators in the TS. We are working to quantify these requirements.

Measurement of the position of the field line from the center of the Production Target to the Stopping Target region to 2 mm has already been declared in the Magnetic Fields specification documents. If in addition the central field line is within 2 mm of the geometric center of the solenoid cryostats, then the problem with >100 MeV/c transport from the production target is solved, and this should also assure that the collimators pass what they are supposed to pass and block what they are supposed to block. If it turns out that the 2 mm spec is too difficult to achieve along the entire length of the solenoid system, then we can investigate relaxing it between collimators, but requiring the field lines to be in the proper place within 2 mm only at the collimators.

Several means of establishing the field line contours have been suggested. The baseline is to map the field components along the entire beam line. A modified current-carrying wire is also being considered. I had proposed the use of a beta source- the low energy electrons or positrons from the beta decay will spiral along the B field lines. A source could be placed one at a time at an array of points at one collimator, and a position-sensitive detector placed at another collimator, to map the transport of particles along the field lines. It is much more convenient to do the mapping at atmospheric pressure with air or helium in the magnet bore, although it could be done, with considerably more difficulty, with

a vacuum. A simulation is needed to see how much the multiple scattering with air molecules spoils the performance of this technique.

We were unable to locate documentation for the field line alignment requirements for MECO; it would be helpful if these could be located.